The Development of the Atomic Model (II)

Atomic Spectra

- When atoms are excited they emit specific wavelengths (_____) of light producing _____ colours.
- The emitted light produces a series of different coloured lines separated from each other.
    - This pattern the lines is known a _____ spectrum or _____spectrum

- The line spectrum for each element is _____ and thus can be used to identify the element.

Bohr (1913)

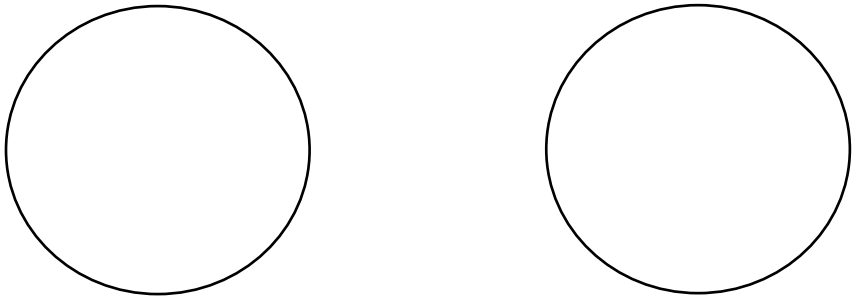
- Bohr developed a new model of the atom based on:
    - The work of Max Planck (1900) on the _____ of electromagnetic energy from hot matter as _____ (or discrete packets) of energy.
    - The work of Einstein (1905) on the absorption and emission of _____ in a "all or none" manner.
    - The emission of specific wavelengths (photons) of light by _____.
    - The _____ energy of electrons in atoms (i.e., electrons can only absorb or release _____ quantities of energy).
- Bohr proposed that:
    - Electrons exist in a series of "_____" circular _____ around the nucleus, which are called _____ (denoted by n).
    - Electrons in orbit _____ radiate energy.
    - Electrons can _____ from one energy level to the other by absorbing or emitting energy.
    - Orbits closer to the nucleus are _____ stable (the lowest possible energy level in the atom is called the _____)
- Bohr's model of the atom can be illustrated as follows:

- Bohr's model explained the emission spectrum of _____.
    - Hydrogen can only produce light corresponding to the energy differences between its _____ energy levels.
- Bohr's model failed to explain the line spectrum of atoms _____ than hydrogen.

Louis de Broglie (1924)

- Given that light has both _____ and _____ properties, de Broglie proposed that particles also have _____ properties.
    - Developed an equation to determine the wavelength of any moving particle given its _____ and _____.
- Applying this idea to the atom, de Broglie proposed that an electron behaves like a _____ _____.

    - If electrons are to behave like _____, de Broglie proposed that the wavelength must fit the _____ of its orbit exactly.



    - This means that there are only a defined number of energy levels, implying that energy is quantized.

Erwin Schrödinger (1926)

- Schrödinger used conventional wave equations to develop a _____model of the atom (a model in which electrons are treated as _____).
    - The equation is known as the _____.
- The solutions to the wave equations (called wave functions):
    - Describe a _____ in the space around the nucleus of an atom called an _____ where an electron spends _____ of its time.
    - An atomic orbital can be viewed as an _____.
    - Contains three variables called _____ numbers that describe an electron's distribution in the atom.

Werner Heisenberg (1927)

- Proposed what is known as the *Heisenberg Uncertainty Principle*, which states that it is impossible to know simultaneously with exact precision, the _____ and _____ of a particle
- This showed that electrons did not move along an orbit.

Max Born (1928)

- Showed that the square of wave functions can be used to determine the _____ of finding an electron in an _____.

A fourth quantum number

- In 1924, Otto Stern and Walter Gerlach discovered that electrons have their own individual _____, responsible for their _____.
- This discovery also explained would explain some inconsistencies with hydrogen's emission spectrum when exposed to a _____.
- A fourth quantum number was introduced to take into consideration the _____ possible values relating to the spin of an electron, which can be either "_____" or "_____".

Questions (Some based on questions found on p. 173 and 180 of the textbook)

1. What is the key difference between the models of the atom proposed by Rutherford and Bohr? What shortcoming of Rutherford's model does this key difference address?
2. Briefly describe how Bohr's model of the atom justifies the line spectrum of hydrogen.
3. How do electrons behaving as standing waves explain the quantized energy of the electron in a hydrogen atom?
4. Unfortunately, a classmate of yours had to miss today's class in which orbitals were discussed orbitals. How would you explain to your friend what an orbital is?
5. What is the Heisenberg Uncertainty Principle? How did it contradict Bohr's model of the atom?
6. What information do solutions to the Schrödinger equation provide?